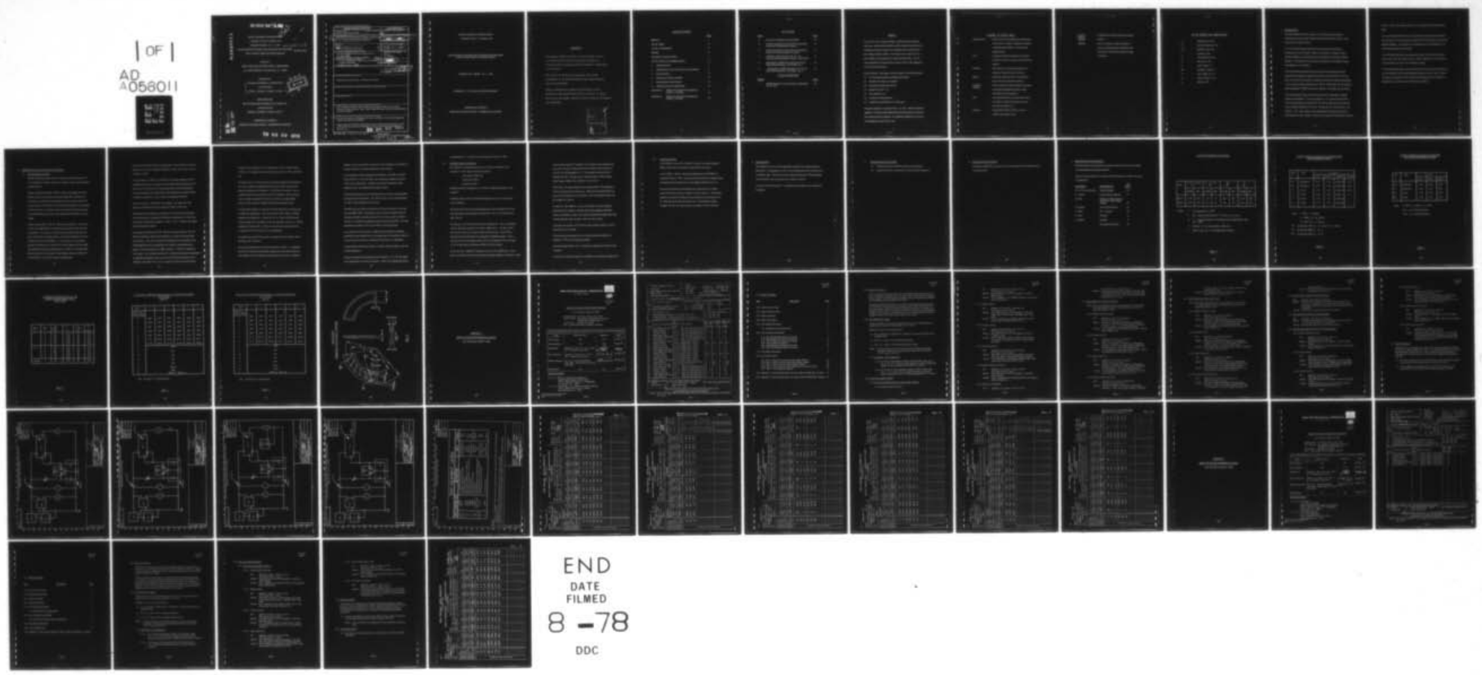
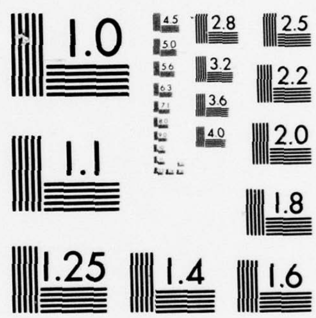
AD-A056 011 CANADIAN COMMERCIAL CORP OTTAWA (ONTARIO) F/G 9/5
MANUFACTURING METHODS AND TECHNIQUES FOR MINIATURE HIGH VOLTAGE--ETC(U)
APR 78 M KORWIN-PAWLOWSKI DAAB07-76-C-0041

UNCLASSIFIED NL

| OF |
AD
A056011



END
DATE
FILMED
8 -78
DDC



12

SEVENTH QUARTERLY PROGRESS REPORT

1 JANUARY 1978 TO 31 MARCH 1978

CONTRACT DAAB07 - 76 - C - 0041

AD-A039-218

MANUFACTURING METHODS AND TECHNIQUES FOR MINIATURE HIGH VOLTAGE HYBRID MULTIPLIER MODULES

A052727

PLACED BY :

NIGHT VISION AND ELECTRO-OPTICAL LABORATORIES

U.S. ARMY ERADCOM, FORT BELVOIR, VA., 22060

387327

CONTRACTOR :

CANADIAN COMMERICAL CORPORATION

70 LYON STREET

OTTAWA, ONTARIO, CANADA K1A 0S6

SUBCONTRACTOR :

ERIE TECHNOLOGICAL PRODUCTS OF CANADA LTD.

5 FRASER AVENUE

TRENTON, ONTARIO, CANADA K8V 5S1

DISTRIBUTION STATEMENT

"APPROVED FOR PUBLIC RELEASE : DISTRIBUTION UNLIMITED"

SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

REPORT DOCUMENTATION PAGE

READ INSTRUCTIONS BEFORE COMPLETING FORM

1. REPORT NUMBER: SEVENTH QUARTERLY REPORT

2. GOVT ACCESSION NO.

3. RECIPIENT'S CATALOG NUMBER

9

4. TITLE (and Subtitle)

6

Manufacturing Methods and Techniques for Miniature High Voltage Hybrid Multiplier Modules.

5. TYPE OF REPORT & PERIOD COVERED: Quarterly progress rept. no. 7, 1 Jan[redacted]-31 Mar[redacted]78.

6. PERFORMING ORG. REPORT NUMBER

7. AUTHOR(s)

10

[redacted]. Michael Korwin-Pawlowski

8. CONTRACT OR GRANT NUMBER(s)

15

DAAB07 - 76 - C - 0041

9. PERFORMING ORGANIZATION NAME AND ADDRESS

Erie Technological Products of Canada Limited
5 Fraser Avenue
TRENTON, Ontario, Canada K8V 5S1

10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS

Project No. 2769766

11. CONTROLLING OFFICE NAME AND ADDRESS

U.S. Army ERADCOM, Night Vision and Electro-Optical Laboratories
Fort Belvoir, Va., 22060

11

12. REPORT DATE: 17 Apr[redacted]78

13. NUMBER OF PAGES: 58

14. MONITORING AGENCY NAME & ADDRESS (if different from Controlling Office)

15. SECURITY CLASS. (of this report): UNCLASSIFIED

12 59p.

15a. DECLASSIFICATION/DOWNGRADING SCHEDULE

16. DISTRIBUTION STATEMENT (of this Report)

Approved for Public Release, Distribution Unlimited

17. DISTRIBUTION STATEMENT (of the abstract entered in Block 20, if different from Report)

18. SUPPLEMENTARY NOTES

19. KEY WORDS (Continue on reverse side if necessary and identify by block number)

High Voltage Multipliers, High Voltage Power Supplies, Night Vision, Second Generation Image Intensifier Tubes, High Voltage Rectifiers, Ceramic Capacitor Banks, Miniature Modules.

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

The results of testing of rectangular and curved multipliers to the Second Engineering Sample requirements are presented.

Steps to improve the frequency performance of the multipliers and optimization of the rectifiers for these devices are discussed. Results of life testing of multipliers are presented.

78 06 09 009

DD FORM 1 JAN 73 1473 EDITION OF 1 NOV 65 IS OBSOLETE

UNCLASSIFIED

SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

387 327 Gu

SEVENTH QUARTERLY PROGRESS REPORT

1 JANUARY 1978 TO 31 MARCH 1978

MANUFACTURING METHODS AND TECHNIQUES FOR MINIATURE HIGH VOLTAGE HYBRID MULTIPLIER MODULES

CONTRACT NO. DAAB07 - 76 - C - 0041

PREPARED BY: DR. MICHAEL KORWIN-PAWLOWSKI

DISTRIBUTION STATEMENT

"APPROVED FOR PUBLIC RELEASE: DISTRIBUTION UNLIMITED"

ABSTRACT

The progress made during the seventh quarter of work on the Manufacturing and Technology Program for Miniature High Voltage Multiplier Modules is described in this report.

The results of testing of rectangular and curved multipliers to the Second Engineering Sample requirements are presented.

Steps to improve the frequency performance of the multipliers and optimization of the rectifiers for these devices are discussed. Results of life testing of multipliers are presented.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF ILLUSTRATIONS

PURPOSE

This Contract covers component designs, mounting and interconnection techniques, tooling and test methods and other manufacturing methods and techniques required for production of rectangular and curved miniature high voltage multiplier modules. These units are to be used in low cost power supplies for second generation image intensifier tubes. The full scope and details of the specification are given in SCS - 495, Appendix A to the First Quarterly Report.

Major milestones in this program consist of delivery of the following items:

(1) First and second engineering samples and test data.

(2) Production line layout and schedule.

(3) Confirmatory samples and test data.

(4) Production line set - up.

(5) Pilot production run.

(6) Production rate demonstration.

(7) Preparation and publication of a final report.

The general approach is to design and set - up a cost - effective production capability, utilizing already established device technologies and materials, and to demonstrate the production line capability to fabricate at the rate of 125 acceptable units per 40 hour week.

GLOSSARY OF SPECIAL TERMS

Capacitor bank:	-	Ceramic wafer with metallizations which perform the function of a number of capacitors connected in parallel (parallel bank) or in series (series capacitor bank).
Cure:	-	To change the physical properties of a material by chemical reaction or by the action of heat and catalyst.
Flash test:	-	Test consisting of instantaneous application of voltage at its specified value to the part.
Hybrid:	-	Technology combining thick - films (capacitor banks) with discrete devices (rectifiers).
Multiplier Modules:	-	Device consisting of capacitor-banks and rectifers connected and packaged to perform voltage multiplication and rectification.
Pad:	-	The metallized area on the ceramic bank acting as a plate of a capacitor and used to make an electrical connection to it.
Rectifier:	-	Semiconductor device with one or more p - n junctions connected in series.

Rectifier - substrate Assembly:	-	A substrate with rectifiers placed and secured within it.
Substrate:	-	Part of a multiplier module consisting of a piece of insulating material machined to accommodate the rectifiers and support the capacitor banks.

LIST OF SYMBOLS AND ABBREVIATIONS

ic	-	charging current (μA)
C_x	-	measured capacitance (pF)
D.F.	-	dissipation factor (%)
f	-	frequency (KHz)
C_i	-	input capacitance (pF)
I_L	-	load current (nA)
vr	-	ripple voltage (V)
V_B	-	breakdown voltage (V)
V_i	-	input voltage (Vp - p)
V_o	-	output voltage (V d.c.)
η	-	efficiency (%)

1. INTRODUCTION

This report describes briefly the progress in the Manufacturing Methods and Techniques for Miniature High Voltage Hybrid Multiplier Modules Program, made during the latest calendar quarter.

In the First Quarterly Report the design and the manufacturing process for rectangular and curved multiplier modules were described. Prototype rectifier-substrate assemblies were fabricated and then redesigned to simplify the assembly operation. The specification covering the requirements for the multiplier modules forms Appendix A of the Report.

In the Second Quarterly Report results of the electrical evaluation of the first sample batch of rectangular capacitor banks TSK 25 - 250 and TSK 25 - 251 were given, the choice of the rectifier was made and electrical test results were presented on non-modular multipliers fabricated with TSK 25 - 250 and TSK 25 - 251 capacitor banks and standard HV20PD four-junction rectifiers, to evaluate these components.

In the Third Quarterly Report results of electrical tests on rectangular multiplier modules were presented. For an input voltage of 1 KV, efficiencies above 96% under no-load conditions and above 95% with 500 nA load currents were achieved for all multipliers assembled with TSK 25 - 250 and TSK 25 - 251 and three - chip rectifiers. Low ripple voltages, input capacitances and charging currents were also measured on these multipliers. Results of the mechanical and electrical evaluation

of TSK 25 - 249 curved capacitor banks were also presented in the Third Quarterly Report.

In the Fourth Quarterly Report work on impregnation and coating of the multipliers was discussed as well as some problems associated with the fabrication of the rectifier-substrate assemblies. The fabrication of rectangular and curved multipliers for the First Engineering Sample was discussed.

In the Fifth Quarterly Report were presented the results of electrical performance testing at the room, high (+52°C) and low (-54°C) temperatures, as well as effects of thermal shock, and high and low temperature storage.

In the Sixth Quarterly Report were presented the results of testing of rectangular and curved multipliers to the Second Engineering Sample requirements, steps to improve the frequency performance of the multipliers and optimization of the rectifiers for these devices, as well as results of life testing of multipliers.

2. FABRICATION AND EVALUATION OF MULTIPLIERS

2.1 Second Engineering Samples

Rectifier-substrate assemblies with HXC 2 devices started in December 1977 were assembled with capacitor banks into multipliers, which were then impregnated and coated.

Thirteen rectangular multipliers TSK 312 - 000 were assembled, 8 of which showed continuity of the rectifier string when tested with a Tektronix 575 Curve-Tracer, with FVD at 10 mA typically 25 to 26.5 volts or 2.08 to 2.21 volts per rectifier. The other five were reworked and yielded 3 more multipliers to a total of eleven. From these, 2 parts were removed at initial testing and one was questionable because of corona effects observed at 1000 V p-p input voltage.

Sixteen curved multipliers TSK 313 - 000 were also assembled. As many as 6 reworks were needed before 14 multipliers showing rectifier string continuity were obtained. This was due to the difficulty of assembling these parts and also to the mismatch of capacitor banks, which had the pad pattern off-set by 2° radially from the required position. From these parts, 3 were removed showing low efficiency at no load (83.5 to 93.5% compared with 99 to 100% for good parts) and high input capacitance (37 to 50 pF @ 1 kV and 20 kHz). Three other devices were removed for high charging current (over 300 μA @ 1 kV and 20 kHz, versus 100 to 130 μA for good devices).

The overall yields after assembly and completing the room temperature electrical testing were 9 out of 13 rectangular multipliers, or 69%, and 8 out of 16 curved multipliers, or 50%.

At room temperature, 1000 V p-p and 20 kHz, the average charging current of acceptable devices was for rectangular and curved multipliers respectively, 100 and 114 μA, while at 35 kHz the corresponding figures were 203 and 238 μA. The curved multipliers also showed higher input capacitances averaging 6.82 pF at 1000 V p-p and 35 kHz, versus 5.12 pF for rectangular multipliers.

There is an increase in capacitance not exceeding 1 pF, typically 0.7 pF, observed with decreasing the input voltage from 1000 V to 500 V p-p.

Thicknesses of the multipliers were held below 0.175" both for the rectangular and curved devices, as measured at the highest extruding points. At the center of the body, the thicknesses ranged from .146" to .161". The parts were coated twice with protective enamel.

Six rectangular multipliers TSK 312 - 000 and six curved multipliers TSK 313 - 000 were submitted to Night Vision Laboratories, Ft. Belvoir as Second Engineering Sample. The results of electrical tests performed on these devices at Erie Technological Products were presented in the "Report on Second Engineering Samples" (Erie Technical Report # 0020 of February 7, 1978) and in Appendix A of this report. The multipliers conformed to the electrical requirements as specified in the applicable paragraphs of Electronics Command Technical Requirements SCS - 495 dated 19 November 1975, with the exception of failing to meet the 150 μA

charging current requirement at room temperature, when the input frequency is 35 kHz. The charging current requirement was not met at $-54^{\circ}C$ and 35 kHz, too.

Per request from U.S. Army Electronics Command and Night Vision Laboratory a new lot of multipliers was fabricated and tested in an effort to optimize the frequency performance of the devices. The multipliers were made in the rectangular modular version using HSC 2 and HFC 2 rectifiers, which in previous tests in multipliers assembled with discrete rectifiers were judged slightly superior to HXC 2 devices, although they had lower production yields.

All three types of devices are 2-junction rectifier stacks with low junction area to achieve low capacitance. HXC are fast recovery (250 - 300 ns, typically, measured in the Tektronixs S circuit with $i_F = i_R = 2$ mA), HSC have similar reverse recovery times, but faster turn-on time, typically 1.8 μs for $i_F = 100$ mA, compared with 3 μs for HXC. HFS have very short reverse recovery and turn-on (typical values 120 ns and 0.4 μs, correspondingly).

We started 2 lots of 400 rectifers each, and ended up with only 80 pcs. HSC 2 and 45 pcs. HFC 2 rectifiers.

The electrical parameters of the rectifiers are given in Table 1. It is apparent that both lots of devices showed higher leakage currents and capacitance than those observed in the lots made previously and used in the discrete multipliers.

Together with the low yields this confirms the initial impressions of the difficulty and poor repetition of manufacturing process of these devices.

Nine rectangular multiplier modules were fabricated, 6 with HSC 2 rectifiers, and 3 with HFC 2. One of the latter was removed after assembly due to open circuit in the rectifier chain. Another was removed at testing due to high charging current, input capacitance and ripple voltage.

The electrical parameters of the remaining parts were tested at room temperature at frequencies of 20 and 35 kHz. The results are given in Erie Technical Report No. 0021, forming Appendix B of this report.

The efficiencies of all parts were above 96.6% at both frequencies, at no load and under 500 nA load. The charging currents at 20 kHz averaged 149 μA for multipliers with HSC 2 rectifiers and was 130 uA for the only part with HFC 2 rectifiers. At 35 kHz the corresponding figures were 337 and 310 μA. The input capacitances were below 7 pF for all multipliers at both frequencies.

As a conclusion of this experiment it appears that what affects the frequency performance of the multipliers most is the capacitance of the rectifiers, while the reverse recovery time and turn-on speed are less critical in our application.

It seems that the rectifier best suited to our needs is the HXC 2 device, with low junction capacitance.

During the Program Review Meeting held on December 15 - 16, 1977 the update of the specification SCS 495 was discussed. A draft of the updated specification

was submitted to U.S. Army Electronics Command on January 31, 1978.

2.2 Reliability Testing of Multipliers

Six multipliers, 2 rectangular and 4 curved, were put on reliability test on November 14, 1977 under the following conditions:

- input voltage 1000 V p-p
- Load current 500 nA
- Temperature 50°C

Reliability testing is conducted in air, without any additional protection of the multipliers.

Reliability testing is done for informational purposes only, not as a requirement on the multipliers.

The devices came from the lots fabricated between July and October 1977 for the First Engineering Sample Submission of October 21, 1977. HV 3 rectifiers were used in this lot.

On February 8, unit #8 was removed from the reliability test. This unit exhibited a drop in efficiency to below 4.3 kV output voltage with a 1 kV input, shortly after the start of the test, but did not deteriorate any farther. Device #8 was retained from the manufactured lot as suspected of substandard quality - since it was showing at tests high ripple voltage (52 V p-p, compared with the lot average of 17.4 V) and rather low efficiency of 90% (97.3% lot average).

On the same day, 4 additional multipliers were put on the reliability test. These parts were retained from the Second Engineering Sample Submission of February 2, 1978.

and were made using HXC 2 rectifiers. Two multipliers were rectangular and two curved. The input voltage in the test was raised to 1150 V p-p to conform with SCS 495 paragraph 4.5.17. The temperature during the test is maintained at 50°C, the load current is drawn through a 10 Gohm resistor. Typical output voltage of the multipliers is 6.4 to 6.6 kV.

Within 48 hrs. the output voltage of one curved multiplier (#6A) dropped to 5.4 kV and remained at this level since. Other devices maintained their output at the initial values until, after 696 hrs, unit 11A exhibited a drop of output voltage to 5.4 kV, too.

On March 16, after 2232 hrs. on test one multiplier was found completely destroyed with the capacitor cracked and the epoxy substrate carbonized. Another unit showed no output, char marks around the High Voltage output lead and the diode chain open circuited. Both units were removed.

At the same time another unit (#3) had the output voltage reduced to 5.35 kV, signifying a loss of one stage.

All three failed units belong to the lot of curved multipliers submitted on October 21, 1977 as First Engineering Sample.

The High Voltage Products Q.C. will perform an analysis of the failures of the multipliers.

The results of reliability testing of the multipliers are summarized in Tables 2 & 3.

2.3 Production Materials

Lots of 400 pcs. each of HFC 2 and HSC 2 rectifiers were made bringing to 5460 to total quantity of rectifiers manufactured for this project.

A lot of 300 pcs. TSK 25 - 260 curved capacitor banks (lot #E3039) was received on March 9, 1978. This brings to 812 the quantity of capacitor banks manufactured for this project by Erie Technological Products at Erie, Pa.

The results of electrical tests and dimensional measurements for 2 sample pieces from this lot are given in Tables 4 & 5 and on Figure 1. The capacitor pad layout conforms more closely with the requirements of the drawing TSK - 25 - 260 than was the case with previous lots. The break down voltage averaged 10.6 kV, but on some pads on one sample it is as low as 8.5 kV.

3. CONCLUSIONS

The multipliers with low junction capacitance rectifiers show improved frequency performance, not depending very much on the switching speed of the rectifiers in the investigated range. They fail to meet the original requirement of 150 μA charging current at 40 kHz, but can meet the limit of 250 μA at 35 kHz.

An analysis of life-testing results is needed before proceeding to the next phase of the program.

4. PROGRAM FOR NEXT QUARTER

4.1 Analyse the results of reliability testing of the multipliers.

4.2 Prepare for the start of manufacture of the confirmatory sample lot.

5. PUBLICATIONS AND REPORTS

No reports or publications were made on the work associated with this program during the current quarter.

6. IDENTIFICATION OF PERSONNEL

Brief descriptions of the background of technical personnel involved were included in the preceding Quarterly Progress Reports.

During the Seventh quarter of the program the following persons worked in their area of responsibility:

INDIVIDUAL	RESPONSIBILITY	HRS. SPENT
Dr. M. Korwin-Pawlowski	Program Manager	83
G. Gordon	Senior Electronic Engineer	11
D. Platt	Manager, Quality Assurance and Control, High Voltage Products	44
D. Archard	Senior Test Technician	46
V. Glenn	Q.C. Inspector	30
K. Cram	Draftsman	6
L. Macklin	Draftsman	3
	Manufacturing Personnel	25

ELECTRICAL PROPERTIES OF RECTIFIERS

TYPE	F.V.D. @ 10 mA (V)		i_R @ 1 kV (nA)		T_{RR} (ns)		C (pF)	
	Average	Max.	Average	Max.	Average	Max.	Average	Max.
HSC 2	1.58	3.00	7.0	10	225	320	0.70	0.80
HFC 2	3.54	4.00	11.2	20	144	170	0.64	0.87

Notes:

1. All measurements at 25°C
2. T_{RR} - measured using Tektronix "S" Circuit $i_F = i_R = 2$ mA
3. C - measured on Boonton RF Admittance Meter Model 33A at 1 MHz and - 100 V.
4. Maximum F.V.D. and i_R tested on 100% of lot
5. Maximum T_{RR} and C in the tested sample of 20 pcs.

TABLE 1

OUTPUT VOLTAGE AT LIFE TEST OF MULTIPLIERS FROM FIRST ENGINEERING SAMPLE

UNIT #	TYPE	Vo (kV)			
		O hrs.	24 hrs.	1344 hrs.	2616 hrs.
57	Rectangular	5.70	5.70	5.70/6.40	6.40
65	Rectangular	5.70	5.70	5.70/6.40	6.40
7	Curved	5.75	5.75	5.75/6.40	5.35
8	Curved	5.35	5.40	4.30/----	----
9	Curved	5.75	5.75	5.75/6.40	----
18	Curved	5.75	5.75	5.75/6.40	----

Notes: $T = 50^{\circ}C$, $i_L = 500$ nA

$V_i = 1000$ V, for $t \leqslant 1344$ hrs.

$V_i = 1150$ V for $t > 1344$ hrs.

#8 - removed after 1344 hrs., Vo = 4.3 kV @ $V_i = 1000$ V

#9 - removed after 2232 hrs., Vo = 0

#18 - removed after 2232 hrs., Vo = 0

TABLE 2

OUTPUT VOLTAGE AT LIFE TEST OF MULTIPLIERS FROM SECOND ENGINEERING SAMPLE

Unit #	Type	Vo, (kV)		
		O hrs.	48 hrs.	1272 hrs.
11A	Rectangular	6.40	6.40	5.40
76	Rectangular	6.45	6.45	6.45
6A	Curved	6.40	5.40	5.20
8A	Curved	6.45	6.45	6.45

Notes: $T = 50^{o}C$, $i_L = 500$ nA, $V_i = 1150$ V

6A, Vo = 5.40 kV after 48 hrs.

11A, Vo = 5.40 kV after 696 hrs.

TABLE 3

ELECTRICAL TEST DATA FOR TSK 25 - 260
CURVED CAPACITOR BANK SAMPLES
LOT # E 3039

UNIT #	PAD #	C_x @ 0kV (pF)	D. F. (%)	C_x @ 6 kV (pF)	V_B (kV)
1	1	90	0.01	63	14.8
	2	89	0.01	62	9.0
	3	88	0.01	62	14.2
	4	89	0.01	62	11.0
	5	86	0.01	60	15.6
	6	74	0.01	52	9.0
2	1	88	0.01	62	8.5
	2	89	0.01	62	9.0
	3	88	0.01	62	9.0
	4	88	0.01	62	8.8
	5	86	0.01	60	8.9
	6	74	0.01	52	9.0
Average		86	0.01	60	10.6

TABLE 4

MECHANICAL INSPECTION DATA FOR TSK 25 - 260 CAPACITOR BANKS

LOT # E 3039

UNIT # 1

PAD #	1	2	3	4	5	6
Dimensions in inches or degrees						
A	.0463	.0473	.0471	.0473	.0459	.0450
B	.0480	.0471	.0491	.0471	.0453	.0442
E	.0401	.0403	.0434	.0455	.0471	.0513
F	.0438	.0414	.0398	.0365	.0351	.0327
H	.0223	.0224	.0237	.0240	.0228	.0223
Q	11° 0'	23° 0'	34° 30'	46° 0'	58° 0'	70° 0'
R	16° 45'	28° 30'	40° 15'	51° 30'	63° 45'	75° 45'
K	.2503					
L1	.505					
L2	.568					
L3	.686					
L4	.748					
M	80° 45'					
N	.0430					
P	.0260 min, .0696 max.					

Note: See figure # 1 for dimensioning.

TABLE 5

MECHANICAL INSPECTION DATA FOR TSK 25 - 260 CAPACITOR BANKS

LOT # E 3039

UNIT # 2

PAD #	1	2	3	4	5	6
Dimensions in Inches or degree						
A	.0463	.0473	.0471	.0473	.0459	.0450
B	.0480	.0471	.0491	.0471	.0453	.0442
E	.0401	.0403	.0434	.0455	.0471	.0513
F	.0438	.0419	.0398	.0365	.0351	.0327
H	.0223	.0224	.0237	.0240	.0228	.0223
Q	11° 0'	23° 0'	35° 0'	47° 0'	58° 30'	70° 30'
R	17° 0'	28° 30'	40° 30'	52° 0'	64° 0'	76° 0'
K	.2852					
L1	.500					
L2	.570					
L3	.685					
L4	.750					
M	80° 0'					
N	.0430					
P	.0279 min, .0713 max.					

Note: See figure # 1 for dimensioning.

TABLE 6

TSK-25-260

DIMENSIONING OF CURVED BANK CAPACITORS

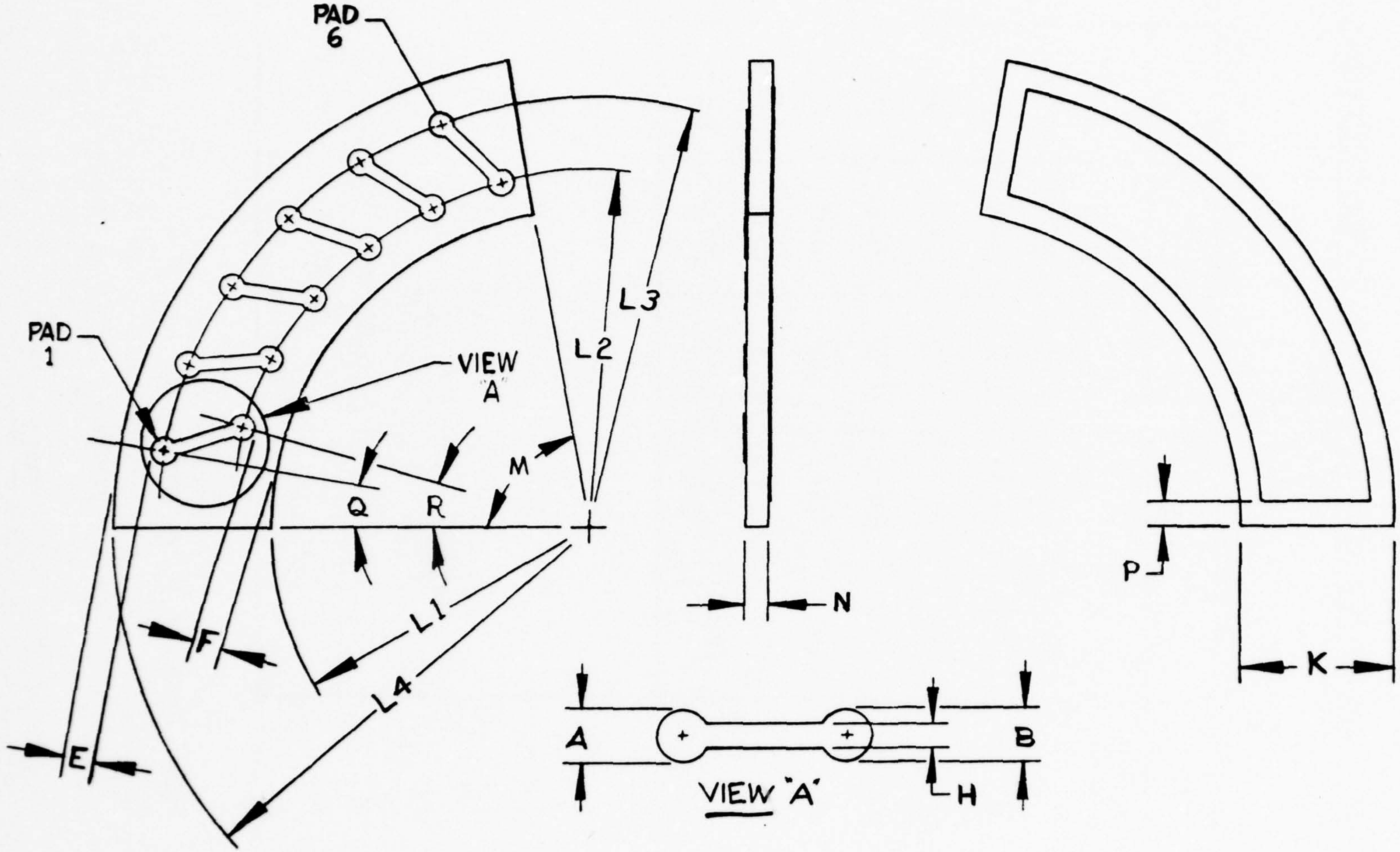


FIG. 1

APPENDIX A

REPORT ON SECOND ENGINEERING SAMPLES

(ERIE TECHNICAL REPORT # 0020)

ERIE TECHNOLOGICAL PRODUCTS
OF CANADA, LIMITED

REPORT ON SECOND ENGINEERING SAMPLES

Erie Technical Report No. 0020

Performed by: Erie Tech. Prod. of Can. Ltd.
Authorized by: Procurement & Production Directorate
USAECOM Fort Monmouth, N.J.
Contract No.: DAAB07-76-C-0041
Ref.: High Voltage Hybrid Multiplier Modules

TEST AND DEMONSTRATION REPORT PERTAINING TO SECOND ENGINEERING SAMPLES			
Item:	Name and Title:	Signature:	Date:
Test Initiated:	N/A	N/A	13 Jan./78
Test Completed:	N/A	N/A	31 Jan./78
Prepared By:	Douglas A. Platt, Q.C./Q.A. Mgr., H. V. Products, Erie Tech.	D Platt	7 Feb/78
Test Technician:	Dennis G. Archard, Q.C. Tech., H. V. Products, Erie Tech.	D. Archard	7 FEB/78
Program Manager:	Dr. M. L. Korwin-Pawlowski, Eng. Mgr., Semiconductor Devices, Erie Tech.	M Pawlowski	7 Feb 78
Final Release:	N/A	N/A	7 Feb./78

Report Distribution:

2 c.c. to: Director, Night Vision Laboratory
Systems Development Technical Area
ATTN: DRSEL-NV-SD (Mr. H. Finkelstein)
Fort Belvoir, Va. 22060

1 c.c. to: Commander, U.S. Army Electronics Command
ATTN: DRSEL-RD-PC (Mr. D. Biser)
Fort Monmouth, N.J. 07703

5 FRASER AVENUE, TRENTON, ONTARIO, CANADA
PHONE: (613) 392-2581 • TELEX: 06-62279
K8V 5S1

REPORT SUMMARY SHEET:	2. System: Night Vision	Action:	Day	Mo.	Yr.
1. Part Name: High Voltage Hybrid Mult. Modules	5. Report No.: ETR 0020	Test Compl.	31	Jan.	78
		Report Compl.	7	Feb.	78
4. Report Title: Erie Technical Report	6. Test Type: Electrical Testing of the Second Engineering Samples				

7. This test (supersedes)(~~supplements~~) Report No.: ETR 0019

8. Type:	8A. Part Description:	9. Vendor	10. Vendor Part No.:	11. Gov. No.:	12. Total Tested:
I	Rectangular Multiplier Module	Erie	TSK-312-000	N/A	6
II	Curved Multiplier Module	Erie	TSK-313-000	N/A	6

13.	Internal Specs. Etc.:	14.	Mil. Spec. Reference
A.	Fort Monmouth Contract No. DAAB07-76-C-0041	D.	Mil.-Std.-202
B.	USAECOM MM & T Requirement No. 15, December, 75	E.	Mil.-Std.-831
C.	USAECOM Technical Requirement No. SCS-495, 19 Nov. 75		

15. Item:	Test or Environment:	Spec. SCS-495 Para.:	Test Details:	Mult. Type: I No. Test:	Mult. Type: I No. Rej.:	Mult. Type: II No. Test:	Mult. Type: II No. Rej.:
1.	O/P Voltage (no load)	3.2.1	Pre environmental (R.T.)	6	0	6	0
2.	Ripple Voltage	3.2.1.4	Pre environmental (R.T.)	6	0	6	0
3.	Charge Current	3.2.1.3	Pre environmental (R.T.)	6	*6	6	*6
4.	Input Capacitance	3.2.1.2	Pre environmental (R.T.)	6	0	6	0
5.	O/P Voltage (full load)	3.2.1	Pre environmental (R.T.)	6	0	6	0
6.	Efficiency Cal.	3.2.1.1	Pre environmental (R.T.)	6	0	6	0
7.	O/P Voltage (no load)	3.2.4.1	High temp. (+52°C)	3	0	3	0
8.	Ripple Voltage	3.2.4.1.4	High temp. (+52°C)	N/A	N/A	N/A	N/A
9.	Charge Current	3.2.4.1.3	High temp. (+52°C)	3	0	3	0
10.	Input Capacitance	3.2.4.1.2	High temp. (+52°C)	3	0	3	0
11.	O/P Voltage (full load)	3.2.4.1.1	High temp. (+52°C)	3	0	3	0
12.	O/P Voltage (no load)	3.2.4.2	Low temp. (-54°C)	3	0	3	0
13.	Ripple Voltage	3.2.5.2.4	Low temp. (-54°C)	N/A	N/A	N/A	N/A
14.	Charge Current	3.2.4.2.3	Low temp. (-54°C)	3	*3	3	*3
15.	Input Capacitance	3.2.4.2.2	Low temp. (-54°C)	3	0	3	0
16.	O/P Voltage (full load)	3.2.4.2.1	Low temp. (-54°C)	3	0	3	0
17.	Thermal Shock	3.2.4.3.1	25 cycles (-65 to +71°C)	6	N/A	6	N/A
18.	High Temp. Storage	3.2.4.3.2	8 hrs. @ +71°C	6	N/A	6	N/A
19.	O/P Voltage (no load)	3.2.1	Post environmental (R.T.)	6	0	6	0
20.	Ripple Voltage	3.2.1.4	Post environmental (R.T.)	6	0	6	0
21.	Charge Current	3.2.1.3	Post environmental (R.T.)	6	*6	6	*6
22.	Input Capacitance	3.2.1.2	Post environmental (R.T.)	6	0	6	0
23.	O/P Voltage (full load)	3.2.1	Post environmental (R.T.)	6	0	6	0
24.	Efficiency Cal.	3.2.1.1	Post environmental (R.T.)	6	0	6	0

16. Summary of Report: See "Test Report Summation" Page 9

17. Tested Beyond Spec. ☐ Yes	18. Vendor Informed: Letter ☐ Rep't ☐ Oral ☐	19. Signed:	20. Contractor:	Subcontractor:

* NOTE: Refer to the applicable "Test Evaluation and Results" Paragraph contained in the body of this report.

3.0) Table of Contents:

4.0) Report Description:

This test and demonstration report (data item B002) pertains to the electrical and environmental evaluation of two "Six Stage High Voltage Multiplier Module" types, supplied as Second Engineering Samples against "Manufacturing Methods and Technology Contract DAAB07-76-C-0041."

The test specimens were tested in accordance with the applicable paragraphs of "Electronics Command Technical Requirement SCS-495, dated 19 Nov./75." The requirements contained in the forementioned document are considered as design goals and subject to change prior to the next submission of Confirmatory Samples. Devices that are marginal failures have not been removed from the sample and their test results are contained in this report.

5.0) Test Sample Description:

The test samples are individually identified by means of an identification no. (label) which is attached to the multiplier's "D1" lead.

Multiplier "hook-up" lead identification:

a) The "ground lead" (ribbon type) is identified by a blue dot located on the multiplier body.

b) The "A.C. input" is the remaining ribbon lead

c) The "D.C. output" is the remaining cylindrical lead.

NOTE: All operational tests were conducted with the ground and D1 leads commoned, and the test specimen totally immersed in Fluorinert "FC-43" (mfg. by 3M Co.).

5.1) Disposition of Test Specimens:

5.1.1) Six (6) type I Rectangular Modules (TSK-312-000, ident. no's.: 10, 70, 71, 72, 73, 74) are being submitted as Second Engineering Samples (item no. 0001AA) against MM & T contract.

5.1.2) Six (6) type II Curved Multiplier Modules (TSK-313-000, ident. no's.: 7, 9, 23, 25, 26, 27) are being submitted as Second Engineering Samples (item no. 0001AA) against MM & T contract.

6.0) Test and Evaluation Results:

6.1) Pre Environmental Electrical Testing (Room Temp.):

6.1.1) Output Voltage (No Load)

Ref.:	Appendix I & II, Sheet 1, Cond. A1 & A2 Test Circuit Fig. 1, Fig. 5
Method:	With 1000 Vp/p @ 20 & 35 KHz applied, record the output voltage
Results:	The 12 multipliers successfully conform to the expected output voltage level.

6.1.2) Ripple Voltage

Ref.:	Appendix I & II, Sheet 1, Cond. B1 & B2 Test Circuit Fig. 3, Fig. 5
Method:	With 1000 Vp/p @ 20 & 35 KHz applied, record the output ripple voltage using a "Jennings Type" scope probe
Results:	The 12 multipliers successfully conform to the $<3\%$ requirement of SCS-495, Para 3.2.1.4.

6.1.3) Charge Current

Ref.:	Appendix I & II, Sheet 1, Cond. C1 & C2 Test Circuit Fig. 4, Fig. 5
Method:	With 1000 Vp/p @ 20 & 35 KHz applied, record the charging current
Results:	The 12 multipliers failed to conform to the $<150\ \mu A$ requirement of SCS-495, Para 3.2.1.3 when tested at 35 KHz.

6.1.4) Input Capacitance

Ref.:	Appendix I & II, Sheet 1, Cond. D1 & D2 Test Circuit Fig. 4, Fig. 5
Method:	With 1000 Vp/p @ 20 & 35 KHz applied, record the input capacitance reading on the variable capacitor
Results:	The 12 multipliers successfully conform to the <8 pF requirement of SCS-495, Para 3.2.1.2.

6.1.5) Output Voltage (Full Load)

Ref.:	Appendix I & II, Sheet 1, Cond. E1 & E2 Test Circuit Fig. 2, Fig. 5
Method:	With 1000 Vp/p @ 20 & 35 KHz applied, record the output voltage
Results:	The 12 multipliers successfully conform to the expected output voltage level.

6.1.6) Efficiency Calculation

Ref.:	Appendix I & II, Sheet 1, Cond. F1 & F2

Test Circuit Fig. 1, Fig. 2, Fig. 5

Method: Using the formula provided in Para 6.3.1 of SCS-495 the calculated multiplier efficiencies, with the output at full load (worse case), exceed the 85% requirement of SCS-495, Para 3.2.1.1.

6.2) <u>High Temperature Electrical Testing</u>

NOTE: Due to test limitations only six (6) multipliers were examined for output voltage (no load & full load), charge current, and input capacitance at +52°C.

6.2.1) Output Voltage (No Load)

Ref.: Appendix I & II, Sheet 2, Column 1
Test Circuit Fig. 1, Fig. 5

Method: With the six multipliers mounted in a temperature chamber at +52°C with an input voltage of 1000 Vp/p @ 35 KHz applied, record the output voltage

Results: The 6 multipliers successfully conform to the expected output voltage level.

6.2.2) Charge Current

Ref.: Appendix I & II, Sheet 2, Column 2
Test Circuit Fig. 4, Fig. 5

Method: With the six multipliers mounted in a temperature chamber at +52°C with an input voltage of 1000 Vp/p @ 35 KHz applied, record the charge current

Results: The 6 multipliers successfully conform to the < 300 μA requirement of SCS-495, Para 3.2.4.1.3.

6.2.3) Input Capacitance

Ref.: Appendix I & II, Sheet 2, Column 3
Test Circuit Fig. 4, Fig. 5

Method: With the six multipliers mounted in a temperature chamber at +52°C with an input voltage of 1000 Vp/p @ 35 KHz applied, record the input capacitance

Results: The 6 multipliers successfully conform to the < 8 pF requirement of SCS-495, Para 3.2.4.1.2.

6.2.4) Output Voltage (Full Load)

Ref.: Appendix I & II, Sheet 2, Column 4 & 5
Test Circuit Fig. 2, Fig. 5

Method: With the 6 multipliers mounted in a temperature chamber at + 52°C with an input voltage of 1000 Vp/p

@ 35 KHz applied, record the output voltage and calculate the efficiency

Results: The multipliers exceed the 80% efficiency requirement of SCS-495, Para 3.2.4.1.1.

6.3) Low Temperature Electrical Testing

NOTE: Due to test limitations only six (6) multipliers were examined for output voltage (no load & full load), charge current, and input capacitance at -54°C.

6.3.1) Output Voltage (No Load)

Ref.: Appendix I & II, Sheet 2, Column 6
Test Circuit Fig. 1, Fig. 5

Method: With the six multipliers mounted in a temperature chamber at -54°C with an input voltage of 1000 Vp/p @ 35 KHz applied, record the output voltage

Results: The 6 multipliers successfully conform to the expected output voltage level.

6.3.2) Charge Current

Ref.: Appendix I & II, Sheet 2, Column 7
Test Circuit Fig. 4, Fig. 5

Method: With all six multipliers mounted in a temperature chamber at -54°C with an input voltage of 1000 Vp/p @ 35 KHz applied, record the charge current

Results: All six units failed to conform to the <150 µA requirement of SCS-495, Para 3.2.4.2.3.

6.3.3) Input Capacitance

Ref.: Appendix I & II, Sheet 2, Column 8
Test Circuit Fig. 4, Fig. 5

Method: With the six multipliers mounted in a temperature chamber at -54°C with an input voltage of 1000 Vp/p @ 35 KHz applied, record the input capacitance.

Results: The 6 multipliers successfully conform to the < 8 pF requirement of SCS-495, Para 3.2.4.2.2.

6.3.4) Output Voltage (Full Load)

Ref.: Appendix I & II, Sheet 2, Column 9 & 10
Test Circuit Fig. 2, Fig. 5

Method: With the 6 multipliers mounted in a temperature chamber at -54°C with an input voltage of 1000 Vp/p @ 35 KHz applied, record the output voltage and cal-

culate the efficiency

Results: The multipliers exceed the 80% efficiency requirement of SCS-495, Para 3.2.4.2.1.

6.4) Thermal Shock Evaluation (Non-Operational)

Ref.: Appendix I & II, Sheet 2, Column 11

Method: The twelve (12) multipliers were tested in accordance with test cond. B-1, Method 107D, of Mil. Std. 202, only the high temperature extreme was reduced to +71°C, per Para 3.2.4.3.1 of SCS-495

Results: See Post Environmental Electrical Test Results.

6.5) High Temperature Storage (Non-Operational)

Ref.: Appendix I & II, Sheet 2, Column 12

Method: The twelve (12) multipliers were subjected to 8 hours storage at +71°C per Para 3.2.4.3.2 of SCS-495

Results: See Post Environmental Electrical Test Results.

6.6) Post Environmental Electrical Testing (Room Temp.)

6.6.1) Output Voltage (No Load)

Ref.: Appendix I & II, Sheet 3, Cond. A2
Test Circuit Fig. 1, Fig. 5

Method: With 1000 Vp/p @ 35 KHz applied, record the output voltage

Results: The 12 multipliers successfully conform to the expected output voltage level.

6.6.2) Ripple Voltage

Ref.: Appendix I & II, Sheet 3, Cond. B2
Test Circuit Fig. 3, Fig. 5

Method: With 1000 Vp/p @ 35 KHz applied, record the output ripple voltage by using a "Jennings Type" scope probe.

Results: The 12 multipliers successfully conform to the <3% requirement of SCS-495 Para 3.2.1.4.

6.6.3) Charge Current

Ref.: Appendix I & II, Sheet 3, Cond. C2
Test Circuit Fig. 4, Fig. 5

Method: With 1000 Vp/p @ 35 KHz applied, record the charging current

Results: All 12 multipliers failed to conform to the <150 μA requirement of SCS-495, Para 3.2.1.3.

6.6.4) Input Capacitance

Ref.:	Appendix I & II, Sheet 3, Cond. D2 Test Circuit Fig. 4, Fig. 5
Method:	With 1000 Vp/p @ 35 KHz applied, record the input capacitance reading on the variable capacitor.
Results:	The 12 multipliers successfully conform to the $<$ 8 pF requirement of SCS-495, Para 3.2.1.2.

6.6.5) Output Voltage (Full Load)

Ref.:	Appendix I & II, Sheet 3, Cond. E2 Test Circuit Fig. 2, Fig. 5
Method:	With 1000 Vp/p @ 35 KHz applied, record the output voltage
Results:	The 12 multipliers successfully conform to the expected output voltage level.

6.6.6) Efficiency Calculation

Ref.:	Appendix I & II, Sheet 3, Cond. F2 Test Circuit Fig. 1, Fig. 2, Fig. 5
Method:	Using the formula provided in Para 6.3.1 of SCS-495 the calculated multiplier efficiencies, with the output at full load (worse case), exceed the 85% requirement of SCS-495, Para 3.2.1.1.

7.0) Report Summation:

In this report we evaluated twelve (12) Second Engineering Multiplier Samples per MM & T contract DDAB07-76-C-0041. The results indicated by the various test paragraphs conclude that none of the multipliers examined conform to "all" the electrical requirements as specified in the applicable paragraphs of SCS-495.

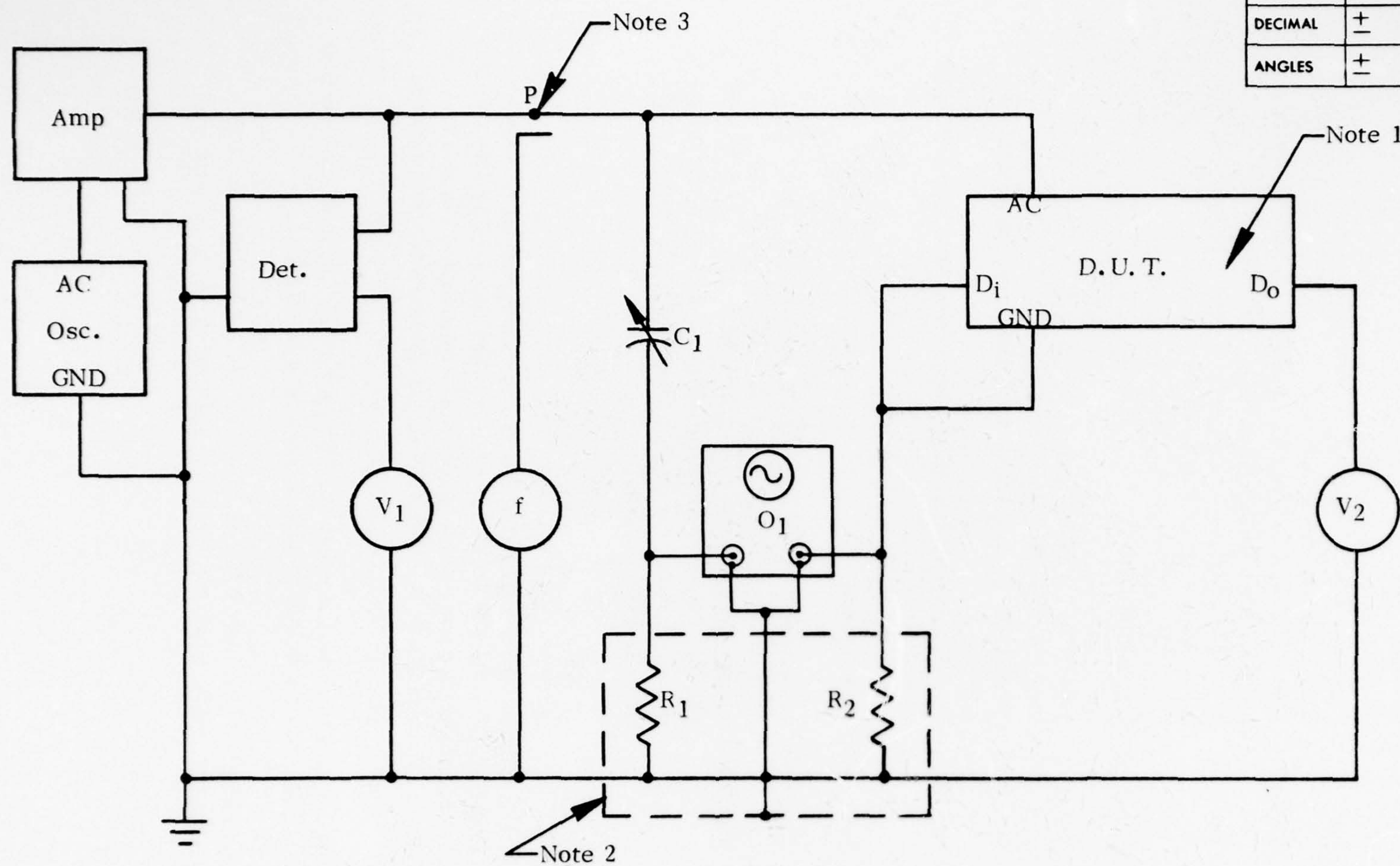
7.1) All twelve multipliers fail to meet the 150 μA charge current requirement at room temp. when the input voltage frequency is 35 KHz.

7.2) All six multipliers evaluated fail to meet the 150 μA charge current requirement at -54°C when the input voltage frequency is 35 KHz.

Figure 1

ACCEPTANCE OF MATERIAL SUBJECT TO APPROVAL OF PRODUCTION SAMPLES BY ENGINEERING DEPARTMENT
DIMENSIONS IN INCHES - DO NOT SCALE THIS DWG.

TOLERANCES UNLESS OTHERWISE SPECIFIED	
FRACTIONS	±
DECIMAL	±
ANGLES	±



REV. NO.	
REVISIONS	

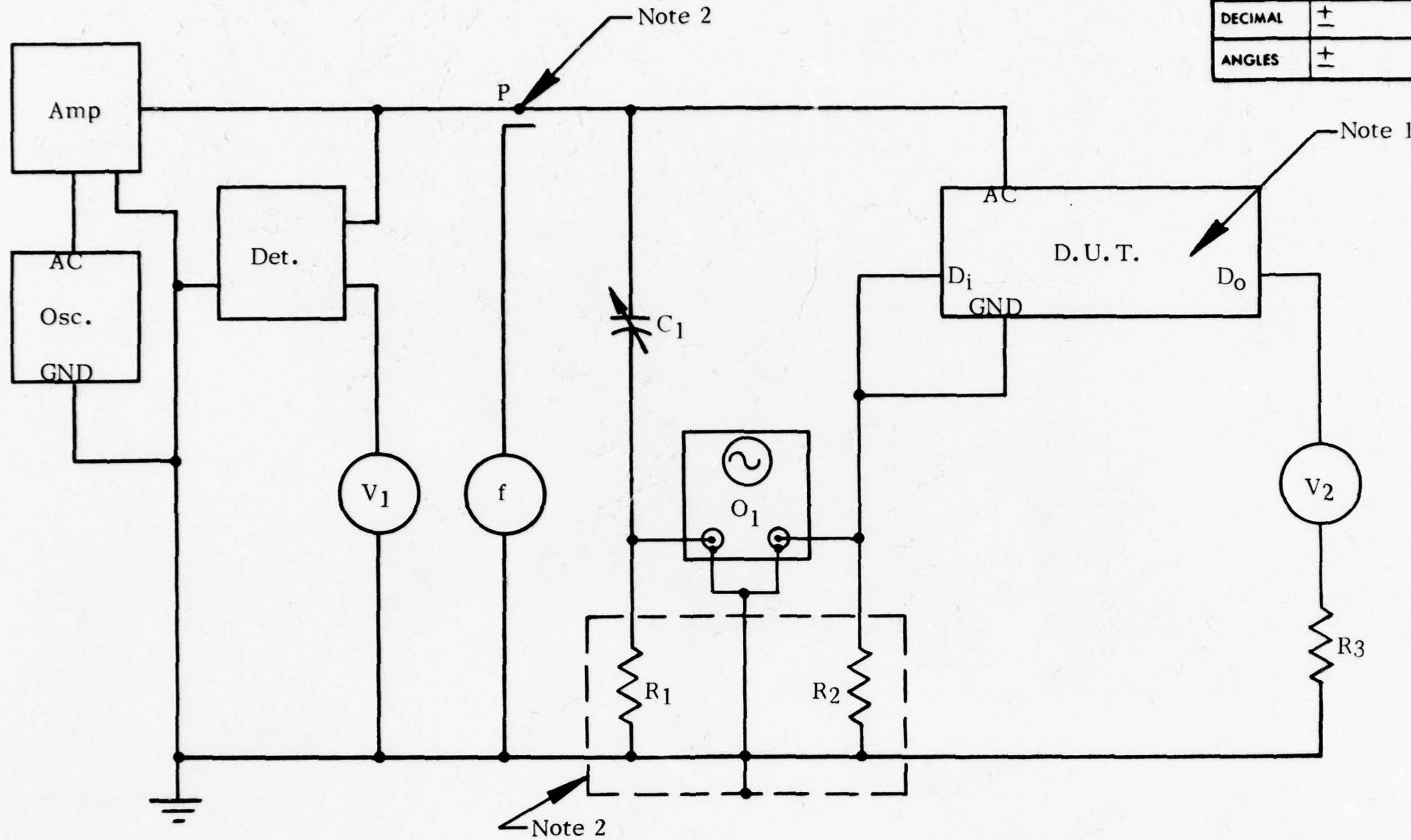
TEST CIRCUIT
for
"No Load"
OUTPUT VOLTAGE EFFICIENCY EVALUATION

DRAWN BY	LARRY MACKLIN	MATERIAL
CHECKED BY	L Platt	FINISH
DATE	11/OCT/77	
ERIE TECHNOLOGICAL PRODUCTS OF CANADA LTD TRENTON, ONTARIO		Figure 1

Figure 2

ACCEPTANCE OF MATERIAL SUBJECT TO APPROVAL OF PRODUCTION SAMPLES BY ENGINEERING DEPARTMENT
DIMENSIONS IN INCHES - DO NOT SCALE THIS DWG.

TOLERANCES UNLESS OTHERWISE SPECIFIED	
FRACTIONS	±
DECIMAL	±
ANGLES	±



REV. NO.
REVISIONS

TEST CIRCUIT
for
"Full Load"
OUTPUT VOLTAGE EFFICIENCY EVALUATION

DRAWN BY	LARRY MACKLIN	MATERIAL	
CHECKED BY	[signature]	FINISH	
DATE	11/OCT/77		

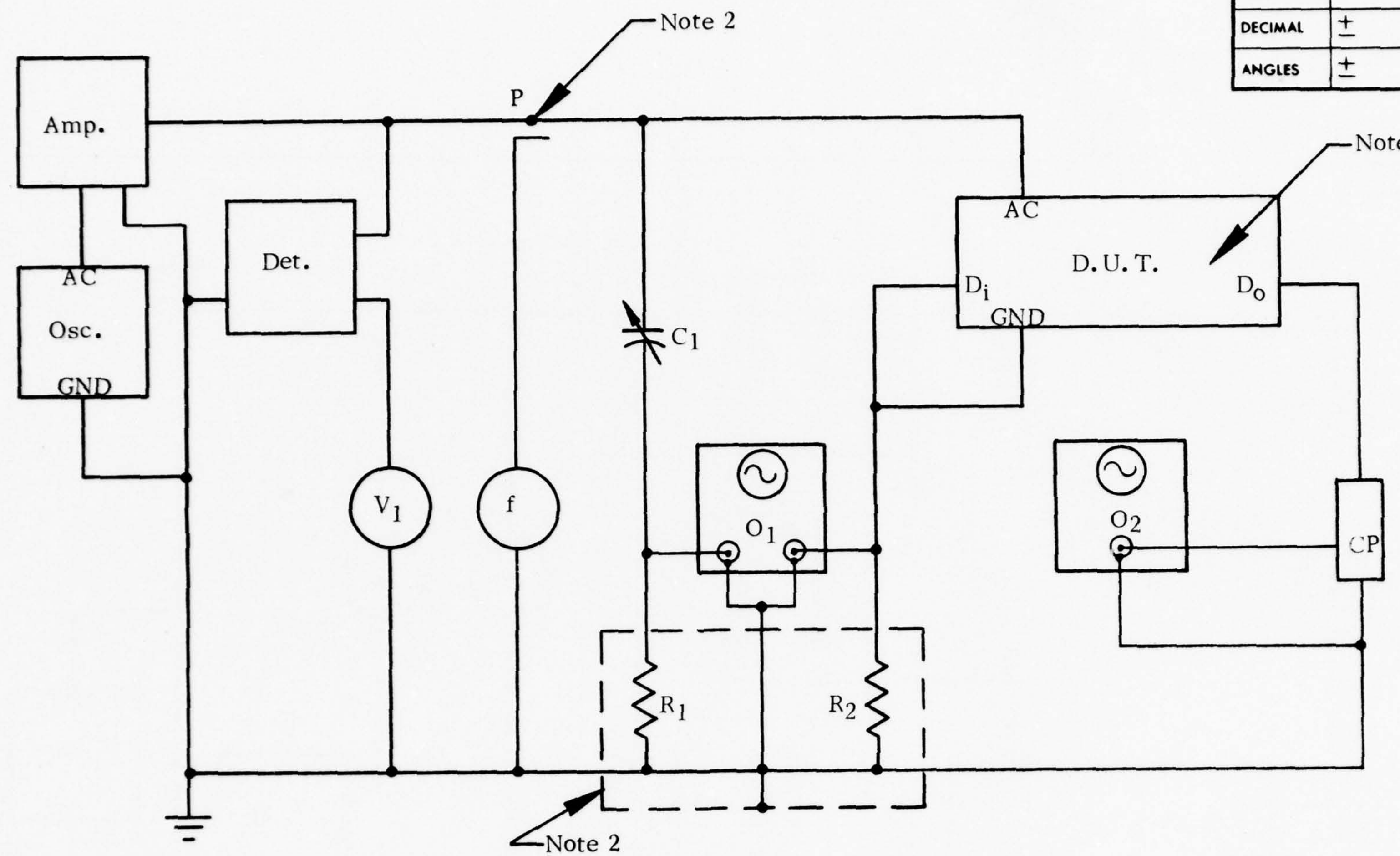
ERIE TECHNOLOGICAL PRODUCTS OF CANADA LTD
TRENTON, ONTARIO

Figure 2

Figure 3

ACCEPTANCE OF MATERIAL SUBJECT TO APPROVAL OF PRODUCTION SAMPLES BY ENGINEERING DEPARTMENT
DIMENSIONS IN INCHES - DO NOT SCALE THIS DWG.

TOLERANCES UNLESS OTHERWISE SPECIFIED	
FRACTIONS	±
DECIMAL	±
ANGLES	±



TEST CIRCUIT
for
OUTPUT RIPPLE VOLTAGE EVALUATION

DRAWN BY LARRY MACKLIN		MATERIAL
CHECKED BY [signature]		FINISH
DATE 11/OCT/77		

ERIE TECHNOLOGICAL PRODUCTS OF CANADA LTD
TRENTON, ONTARIO

Figure 3

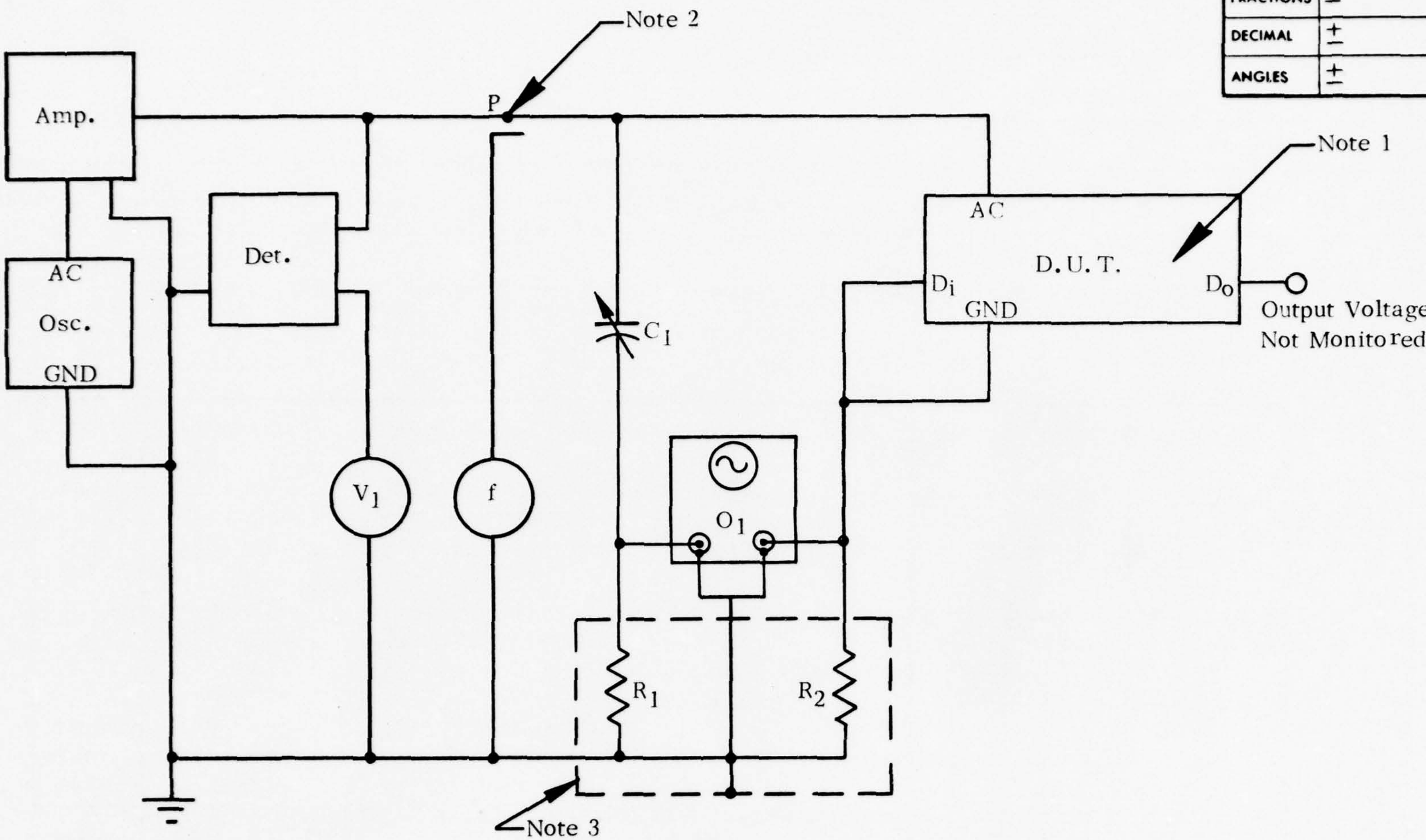
REV. NO.

REVISIONS

Figure 4

ACCEPTANCE OF MATERIAL SUBJECT TO APPROVAL OF PRODUCTION SAMPLES BY ENGINEERING DEPARTMENT
DIMENSIONS IN INCHES - DO NOT SCALE THIS DWG.

TOLERANCES UNLESS OTHERWISE SPECIFIED	
FRACTIONS	±
DECIMAL	±
ANGLES	±



REVISIONS | REV. NO.

TEST CIRCUIT
for
INPUT CAPACITANCE
AND CHARGE CURRENT EVALUATION

DRAWN BY	LARRY MACKLIN	MATERIAL
CHECKED BY		FINISH
DATE	11/OCT/77	

ERIE TECHNOLOGICAL PRODUCTS OF CANADA LTD
TRENTON, ONTARIO

Figure 4

Figure 5

ACCEPTANCE OF MATERIAL SUBJECT TO APPROVAL OF PRODUCTION SAMPLES BY ENGINEERING DEPARTMENT
DIMENSIONS IN INCHES - DO NOT SCALE THIS DWG.

TOLERANCES UNLESS OTHERWISE SPECIFIED	
FRACTIONS	±
DECIMAL	±
ANGLES	±

TEST EQUIPMENT LISTING

REF.	CONTROL NO.	DESCRIPTION	MFG.	MODEL
Amp.	AM193	AC Amplifier (Power Source)	Hewlett Packard	251T
Osc.	FPD72	Oscillator (Function Generator)	Hewlett Packard	3310A
Det.	-----	Peak to Peak Detector	Erie	----
V_1	VM041	Electrostatic Voltmeter (0 to 2000 Vdc)	Beckman	LVE
V_2	VM031	Electrostatic Kilovoltmeter (0 to 15 KVdc)	Hallmark	KVE
f	FM004	Electronic Counter	Hewlett Packard	5321A
O_1	AM166	Dual Channel Oscilloscope	Tektronix	536(T)(CA)
O_2	AM305	Oscilloscope	Tektronix	545(H)
CP	TEX 105-300	Capacitance Probe for Ripple Measurement	Erie	----
R_1 & R_2	R_1 & R_2	Precision Resistors (1 K ohm ± 0.01%)	General Radio	1440
R_3	R_3	Load Resistor (10 G ohm ± 10%)	Resistance Prod. Corp.	BBV
C_1	CM004	Variable Capacitor	General Radio	1422CC

NOTES:

(1) "D. U. T." is the device under test, which in this case will be either TSK 312-000 or TSK 313-000 multipliers, immersed in FC-43.

(2) Shielding and coax cable connected to ground with all leads as short as possible.

(3) Point "P" is the location of the proximity electromagnetic coupling of the electronic (frequency) counter.

REV. NO.

REVISIONS

TEST EQUIPMENT LISTING

DRAWN BY	LARRY MACKLIN	MATERIAL	
CHECKED BY	[signature]	FINISH	
DATE	11/OCT/77		
ERIE TECHNOLOGICAL PRODUCTS OF CANADA LTD TRENTON, ONTARIO		Figure 5	

THIS PAGE IS BEST QUALITY PRACTICABLE
FROM COPY FURNISHED TO DDC

ERIE TECHNC GICAL PRODUCTS
OF C. NADA, LTD.

QUALITY CONTROL DEP'T. – RECORDED DATA SHEET

FILE NO. ETR 0020

Test # A. PENDIX I

SHEET # 1 OF 3

NOTES # 2ND. ENG. SAMPLE

P.O. DAAB07-76-C-0041

F.O. 7459801-S2

QTY. 6 pcs.

TEST Electrical Evaluation (PRE-ENVIROMENTAL)

PART T.S.K. 312-000 (6 STAGE RECT. MULTIPLIER MODULE)

SPECIAL DETAILS Re.: Fort Monmouth Specification SCS-495

Start Date 13 JAN./78

Finish Date 16 JAN./78

Tested By D.A.

Approved By QC Insp. ERIE 20

Test Date	13JAN/78											
Test Cond.	"A1"	"A2"	"B1"	"B2"	"C1"	"C2"	"D1"	"D2"	"E1"	"E2"	"F1"	"F2"
Input Volt.	1000Vp/p	1000Vp/p	1000Vp/p	1000Vp/p	1000Vp/p	1000Vp/p	1000Vp/p	1000Vp/p	1000Vp/p	1000Vp/p	1000Vp/p	1000Vp/p
Test Freq.	20KHz	35KHz	20KHz	35KHz	20KHz	35KHz	20KHz	35KHz	20KHz	35KHz	20KHz	35KHz
Load Current	<2nA	<2nA	<2nA	<2nA	<2nA	<2nA	<2nA	<2nA	500nA	500nA	500nA	500nA
Parameter	O/P Volt.	O/P Volt.	Rip. Volt.	Rip. Volt.	Chg. Cur.	Chg. Cur.	In. Cap.	In. Cap.	O/P Volt.	O/P Volt.	Cal. Eff.	Cal. Eff.
Units	Vdc	Vdc	Vp/p	Vp/p	µA	µA	pF	pF	Vdc	Vdc	%	%
Requirement	321	321	3214 <3%p/p	3214 <3%p/p	3213	3213 <150µA	3212 <8pF	3212 <8pF	321	321	3211 85% min	3211 85% min
IDENTIFICATION NUMBER:												
10	5900	5900	26.0	26.0	103	215*	5.26	5.36	5890	5880	98.1	98.0
70	5950	5950	15.6	22.1	100	205*	4.98	5.02	5900	5900	98.3	98.3
71	5920	5920	22.1	27.3	110	210*	5.10	5.16	5900	5900	98.3	98.3
72	5920	5920	23.4	23.4	100	220*	5.48	5.54	5900	5900	98.3	98.3
73	5950	5950	20.8	22.1	95	185*	4.82	4.86	5910	5910	98.5	98.5
74	5940	5940	18.2	19.5	95	200*	5.10	5.13	5900	5900	98.3	98.3

THIS PAGE IS BEST QUALITY PRACTICABLE
FROM COPY FURNISHED TO DDC

ERIE TECHNOLOGICAL PRODUCTS
OF CANADA, LTD.

QUALITY CONTROL DEP'T. - RECORDED DATA SHEET

FILE NO. ETR 0020

Test # APPENDIX I

SHEET # 2 OF 3

NOTES # 2ND. ENG. SAMPLES

P.O. DAAB07-76-C-0041

F.O. 7459801-S2

QTY. 3 pcs.

TEST Environmental Evaluation

PART T.S.K. 312-000 (6 STAGE RECT. MULT. MODULE)

SPECIAL DETAILS Re.: Fort Monmouth Specification SCS-495

Start Date 18 JAN./78

Finish Date 27 JAN./78

Tested By D.A. Q.A. LAB.

Approved By QC Insp ERIE 20

Test Date	18 JAN/78					18 JAN/78					23 JAN/78	27 JAN/78
Test Cond.	← High Temperature Performance @ +52°C →					← Low Temperature Performance @ -54°C →					Thermal Shock	High Temp. Storage
Input Volt.	1000Vp/p	1000Vp/p	1000Vp/p	1000Vp/p	1000Vp/p	1000Vp/p	1000Vp/p	1000Vp/p	1000Vp/p	1000Vp/p		
Test Freq.	35KHz	35KHz	35KHz	35KHz	35KHz	35KHz	35KHz	35KHz	35KHz	35KHz		
Load Current	<2nA	<2nA	<2nA	500nA	500nA	<2nA	<2nA	<2nA	500nA	500nA	Non-op	Non-op
Parameter	O/P Volt.	Chg.Cur.	In.Cap.	O/P Volt.	Cal.Eff.	O/P. Volt.	Chg.Cur.	In.Cap.	O/P Volt.	Cal.Eff.		
Units	Vdc	µA	pF	Vdc	%	Vdc	µA	pF	Vdc	%		
Requirement	3241	32413 <300µA	32412 <8pF	3241	80% min.	3242	32432 <150µA	32422 <8pF	3242	80% min.	32431	32432
10	5890	280	5.05	5850	97.5	5910	155 *	5.10	5910	98.5		
70	5930	265	5.38	5870	97.8	5950	160 *	4.69	5900	98.3		
74	5940	250	5.87	5900	98.3	5940	170 *	5.52	5900	98.3		

IDENTIFICATION NUMBER:

THERMAL SHOCK: Per MIL. STD. 202, 107D, B-1 25 cycles with each cycle being 1/2 Hr. at each temp. extreme -65°C & +71°C.

HIGH TEMP. STORAGE: Mult's. subjected to an eight (8) hour non-operational storage test @ 171°C.

Test #

APPENDIX I

SHEET # 3 OF 3

NOTES # 2ND. ENG. SAMPLE

P.O. DAAB07-76-C-0041

F.O. 7459801-S2

QTY. 6 pcs.

ERIE TECHNO GICAL PRODUCTS
OF CANADA, LTD.

QUALITY CONTROL DEP'T. – RECORDED DATA SHEET

FILE NO. ETR 0020

TEST Electrical Evaluation (POST ENVIROMENTAL)

PART T.S.K. 312-000 (6 STAGE RECT. MULT. MODULE)

SPECIAL DETAILS Re.: Fort Monmouth Specification SCS-495

Start Date 30 JAN./78

Finish Date 30 JAN./78

Tested By D.A.

Approved By QC INSP ERIE 20

Test Date												
Test Cond.	"A1"	"A2"	"B1"	"B2"	"C1"	"C2"	"D1"	"D2"	"E1"	"E2"	"F1"	"F2"
Input Volt.	1000Vp/p	1000Vp/p	1000Vp/p	1000Vp/p	1000Vp/p	1000Vp/p	1000Vp/p	1000Vp/p	1000Vp/p	1000Vp/p	1000Vp/p	1000Vp/p
Test Freq.	20KHz	35KHz	20KHz	35KHz	20KHz	35KHz	20KHz	35KHz	20KHz	35KHz	20KHz	35KHz
Load Current	<2nA	<2nA	<2nA	<2nA	<2nA	<2nA	<2nA	<2nA	500nA	500nA	500nA	500nA
Parameter	O/P Volt.	O/P Volt.	Rip. Volt	Rip. Volt	Chg. Cur.	Chg. Cur.	In. Cap.	In. Cap.	O/P Volt.	O/P Volt.	Cal. Eff.	Cal. Eff.
Units	Vdc	Vdc	Vp/p	Vp/p	µA	µA	pF	pF	Vdc	Vdc	σ	σ
Requirement	321	321	3214 <3%p/p	3214 <3%p/p	3213	3213 <150µA	3212 <8pF	3212 <8pF	321	321	3211 85% min	3211 85% min
10	N/A	5900	N/A	23.4	N/A	245 *	N/A	5.27	N/A	5880	N/A	98.0
70		5920		22.1		245 *		5.36		5900		98.3
71		5920		27.3		240 *		5.32		5900		98.3
72		5920		24.7		250 *		5.77		5900		98.3
73		5950		23.4		215 *		5.09		5910		98.5
74		5930		18.2		230 *		5.33		5900		98.3

IDENTIFICATION NUMBER:

ERIE TECHNO GICAL PRODUCTS
OF CANADA, LTD.

Test #
APPENDIX II

SHEET # 1 OF 3
NOTES # 2ND. ENG. SAMPLE
P.O. DAAB07-76-C-0041
F.O. 7460301-S1
QTY. 6pcs

QUALITY CONTROL DEP'T. – RECORDED DATA SHEET

FILE NO. ETR 0020

TEST Electrical Evaluation (PRE-ENVIROMENTAL)
PART T.S.K. 313-000 (6 STAGE CURVED MULT. MODULE)
SPECIAL DETAILS Re.: Fort Monmouth Specification SCS-495

Start Date 13 JAN./78
Finish Date 16 JAN./78
Tested By D.A.
Approved By QC Insp ERIE 20

Test Date	13 JAN/78											
Test Cond.	"A1"	"A2"	"B1"	"B2"	"C1"	"C2"	"D1"	"D2"	"E1"	"E2"	"F1"	"F2"
Input Volt.	1000Vp/p	1000Vp/p	1000Vp/p	1000Vp/p	1000Vp/p	1000Vp/p	1000Vp/p	1000Vp/p	1000Vp/p	1000Vp/p	1000Vp/p	1000Vp/p
Test Freq.	20KHz	35KHz	20KHz	35KHz	20KHz	35KHz	20KHz	35KHz	20KHz	35KHz	20KHz	35KHz
Load Current	<2nA	<2nA	<2nA	<2nA	<2nA	<2nA	<2nA	<2nA	500nA	500nA	500nA	500nA
Parameter	O/P Volt.	O/P Volt	Rip. Volt	Rip. Volt	Chg. Cur.	Chg. Cur.	In. Cap.	In. Cap.	O/P Volt.	O/P Volt.	Cal. Eff.	Cal. Eff.
Units	Vdc	Vdc	Vp/p	Vp/p	μA	μA	pF	pF	Vdc	Vdc	%	%
Requirement	321	321	3214 <3%p/p	3214 <3%p/p	3213	3213 <150μA	3212 <8pF	3212 <8pF	321	321	3211 85% min	3211 85% min
7	5990	5990	16.9	16.9	130	265	7.08	7.14	5990	5940	99.8	99.0
9	6000	6000	13.0	14.3	110	225	7.40	6.76	5990	5980	99.8	99.6
23	6000	6000	6.5	14.3	125	245	6.95	6.96	5980	5960	99.6	99.3
25	6000	5990	18.2	18.2	115	245	6.73	6.73	5990	5970	99.8	99.5
26	6000	6000	13.0	13.0	115	245	6.60	6.60	5980	5970	99.6	99.5
27	6000	6000	11.7	11.7	100	210	6.42	6.42	5990	5980	99.8	99.6

IDENTIFICATION NUMBER:

Test #

APPENDIX II

SHEET # 2 OF 3

NOTES # 2ND. ENG. SAMPLE

P.O. DAAB07-76-C-0041

F.O. 7460301-S1

QTY. 3 pcs.

ERIE TECHNC_ GICAL PRODUCTS
OF CANADA, LTD.

QUALITY CONTROL DEP'T. – RECORDED DATA SHEET

FILE NO. ETR 0020

TEST Environmental Evaluation

PART T.S.K.313-000 (6 STAGE CURVED MULT. MODULE)

SPECIAL DETAILS Re.: Fort Monmouth Specification SCS-495

Start Date 18 JAN./78

Finish Date 27 JAN./78

Tested By D.A., Q.A. LAB.

Approved By Q.C. Insp. ERIE 2?

Test Date	18 JAN/78					18 JAN/78					23 JAN/78	27 JAN/78
Test Cond.	← High Temperature Performance @ +52°C →					← Low Temperature Performance @ -54°C →					Thermal	High
Input Volt.	1000Vp/p	1000Vp/p	1000Vp/p	1000Vp/p	1000Vp/p	1000Vp/p	1000Vp/p	1000Vp/p	1000Vp/p	1000Vp/p	Shock	Temp.
Test Freq.	35KHz	35KHz	35KHz	35KHz	35KHz	35KHz	35KHz	35KHz	35KHz	35KHz		Storage
Load Current	<2nA	<2nA	<2nA	500nA	500nA	<2nA	<2nA	<2nA	500nA	500nA	Non-op	Non-op
Parameter	O/P Volt	Chg.Cur.	In.Cap	O/P Volt.	Cal.Eff.	O/P. Volt.	Chg.Cur.	In.Cap.	O/P Volt.	Cal.Eff.		
Units	Vdc	μA	pF	Vdc	%	Vdc	μA	pF	Vdc	%		
Requirement	3241	32413	32412	3241		3242	32432	32422	3242		32431	32432
		<300μA	<8pF		80% min.		<150μA	<8pF		80% min.		
7	5980	290	7.75	5960	99.3	5980	175 *	7.28	5980	99.6		
23	5990	235	6.73	5960	99.3	5990	205 *	6.82	5960	99.3		
27	6000	290	6.51	5980	99.6	6000	200 *	6.62	5980	99.6		

IDENTIFICATION NUMBER:

THERMAL SHOCK: Per MIL. STD. 202, 107D, B-1
25 cycles with each cycle being 1/2 Hr.
at each temp. extreme -65°C & 171°C.

HIGH TEMP. STORAGE: Mult's. subjected to an eight (8)
hour non-operational storage
test @ 171°C.

Test

ERIE TECHNOLOGICAL PRODUCTS
OF CANADA, LTD.

QUALITY CONTROL DEP'T. – RECORDED DATA SHEET

APPENDIX II

SHEET # 3 OF 3

NOTES # 2ND. ENG. SAMPLE

P.O. DAAB07-76-C-0041

F.O. 7460301-S1

QTY. 6 pcs.

FILE NO. ETR 0020

TEST Electrical Evaluation (POST ENVIROMENTAL)

PART T.S.K. 313-000 (6 STAGE CURVED MULT. MODULE)

SPECIAL DETAILS Re.: Fort Monmouth Specification SCS-495

Start Date 31 JAN./78

Finish Date 31 JAN./78

Tested By D.A.

Approved By QC Insp ERIE 20

Test Date												
Test Cond.	"A1"	"A2"	"B1"	"B2"	"C1"	"C2"	"D1"	"D2"	"E1"	"E2"	"F1"	"F2"
Input Volt.	1000Vp/p	1000Vp/p	1000Vp/p	1000Vp/p	1000Vp/p	1000Vp/p	1000Vp/p	1000Vp/p	1000Vp/p	1000Vp/p	1000Vp/p	1000Vp/p
Test Freq.	20KHz	35KHz	20KHz	35KHz	20KHz	35KHz	20KHz	35KHz	20KHz	35KHz	20KHz	35KHz
Load Current	<2nA	<2nA	<2nA	<2nA	<2nA	<2nA	<2nA	<2nA	500nA	500nA	500nA	500nA
Parameter	O/P Volt.	O/P Volt.	Rip. Volt.	Rip. Volt.	Chg. Cur.	Chg. Cur.	In. Cap.	In. Cap.	O/P Volt.	O/P Volt.	Cal. Eff.	Cal. Eff.
Units	Vdc	Vdc	Vp/p	Vp/p	µA	µA	pF	pF	Vdc	Vdc	%	%
Requirement	321	321	3214 <3%p/p	3214 <3%p/p	3213	3213 <150µA	3212 <8pF	3212 <8pF	321	321	3211 85% min	3211 85% min
IDENTIFICATION NUMBER:												
7	N/A	5990	N/A	15.6	N/A	290	N/A	7.40	N/A	5930	N/A	98.8
9		6000		13.0		275		7.24		5980		99.6
23		6000		13.0		275		7.30		5980		99.6
25		5990		16.9		265		7.01		5970		99.5
26		6000		10.4		285		6.86		5980		99.6
27		6000		11.7		235		6.71		5990		99.8

THIS PAGE IS BEST QUALITY PRACTICABLE FROM COPY FURNISHED TO DDC

APPENDIX B

REPORT ON SECOND ENGINEERING SAMPLES

(ERIE TECHNICAL REPORT # 0021)

ERIE TECHNOLOGICAL PRODUCTS

OF CANADA. LIMITED

ERIE TECHNOLOGICAL PRODUCTS OF CANADA LIMITED

ERIE

REPORT ON SECOND ENGINEERING SAMPLES

Erie Technical Report No. 0021

Performed by: Erie Tech. Prod. of Can. Ltd.
Authorized by: Procurement & Production Directorate
USAECOM Fort Monmouth, N.J.
Contract No.: DAAB07-76-C-0041
Ref.: High Voltage Hybrid Multiplier Modules

TEST AND DEMONSTRATION REPORT PERTAINING TO SECOND ENGINEERING SAMPLES

Item:	Name and Title:	Signature:	Date:
Test Initiated:	N/A	N/A	22 Mar./78
Test Completed:	N/A	N/A	23 Mar./78
Prepared By:	Douglas A. Platt, Q.C./Q.A. Mgr., H. V. Products, Erie Tech.	D Platt	30 MAR./78
Test Technician:	Dennis G. Archard, Q.C. Tech., H. V. Products, Erie Tech.	D Archard	4 APR/78
Program Manager:	Dr. M. L. Korwin-Pawlowski, Eng. Mgr., Semiconductor Devices, Erie Tech.	M Pawlowski	4 APR 78
Final Release:	N/A	N/A	29 Mar./78

Report Distribution:

2 c.c. to: Commander
U.S. Army ERADCOM
Night Vision and Electro-Optical Laboratories
ATTN: DELNV-SI (Mr. H. F. Finkelstein)
Fort Belvoir, Va. 22060

1 c.c. to: Commanding General
U.S. Army ERADCOM
ATTN: DELSD-D-PC (Mr. D. Biser)
Fort Monmouth, N.J. 07703

5 FRASER AVENUE, TRENTON, ONTARIO, CANADA
PHONE: (613) 392-2581 • TELEX: 06-62279
K8V 5S1

REPORT SUMMARY SHEET:	2. System: Night Vision	Action:	Day	Mo.	Yr.
1. Part Name: High Voltage Hybrid Mult. Modules	5. Report No.: ETR 0021	Test Compl.	23	Mar.	78
		Report Compl.	29	Mar.	78
4. Report Title: Erie Technical Report	6. Test Type: Electrical Testing of the Second Engineering Samples				

7. This test (~~supersedes~~)(supplements) Report No.: ETR 0020

8. Type:	8A. Part Description:	9. Vendor	10. Vendor Part No.:	11. Gov. No.:	12. Total Tested:
I	Rectangular Multiplier Module	Erie	TSK-312-000	N/A	7

13.	Internal Specs. Etc.:	14.	Mil. Spec. Reference
A.	Fort Monmouth Contract No. DAAB07-76-C-0041	D.	Mil.-Std.-202
B.	USAECOM MM & T Requirement No. 15, December, 75	E.	Mil.-Std.-831
C.	USAECOM Technical Requirement No. SCS-495, 19 Nov. 75		

15. Item:	Test or Environment:	Spec. SCS-495 Para.:	Test Details:	Mult. Type I No. Test:	No. Rej.:		
1.	O/P Voltage (no load)	3.2.1	Room Temp. at two freq's	7	0		
2.	Ripple Voltage	3.2.1.4	Room Temp. at two freq's	7	0		
3.	Charge Current	3.2.1.3	Room Temp. at two freq's	7	*7		
4.	Input Capacitance	3.2.1.2	Room Temp. at two freq's	7	0		
5.	O/P Voltage (full load)	3.2.1	Room Temp. at two freq's	7	0		
6.	Efficiency Cal.	3.2.1.1	Room Temp. at two freq's	7	0		

16. Summary of Report: See "Test Report Summation" Page 6

17. Tested Beyond Spec. Yes	18. Vendor Informed: Letter Rep't Oral	19. Signed:	20. Contractor:	Subcontractor:

* NOTE: Refer to the applicable "Test Evaluation and Results" Paragraph contained in the body of this report.

3.0) Table of Contents:

4.0) Report Description:

This test and demonstration report (data item B002) pertains to the electrical evaluation of a "Rectangular Six Stage High Voltage Multiplier Module", supplied as Second Engineering Samples against "Manufacturing Methods and Technology Contract DAAB07-76-C-0041."

The test specimens were tested in accordance with the applicable paragraphs of "Electronics Command Technical Requirement SCS-495, dated 19 Nov./75." The requirements contained in the forementioned document are considered as design goals and subject to change prior to the next submission of Confirmatory Samples. Devices that are marginal failures have not been removed from the sample and their test results are contained in this report.

5.0) Test Sample Description:

The test samples are individually identified by means of an identification no. (label) which is attached to the multiplier's "D1" lead.

Multiplier "hook-up" lead identification:

a) The "ground lead" (ribbon type) is identified by a blue dot located on the multiplier body.

b) The "A.C. input" is the remaining ribbon lead.

c) The "D.C. output" is the remaining cylindrical lead.

NOTE: All operational tests were conducted with the ground and D1 leads commoned, and the test specimen totally immersed in Fluorinert "FC-43" (mfg. by 3M Co.).

5.1) Disposition of Test Specimens:

5.1.1) Five (5) type I Rectangular Modules (TSK-312-000, identi. no's.: 77, 78, 79, 80 & 84) are being submitted as Second Engineering Samples (item no. 0001AA) against MM & T contract.

5.1.2) Two (2) type I Rectangular Modules (TSK-312-000, ident. no's.: 81 & 82) are being held at Erie for further electrical evaluation.

6.0) Test and Evaluation Results:

6.1) Electrical Testing (Room Temp.):

6.1.1) Output Voltage (No Load)

Ref.: Appendix I, Sheet 1, Cond. A1 & A2
Test Circuit Fig. 1, Fig. 5

Method: With 1000 Vp/p @ 20 & 35 KHz applied, record the output voltage

Results: The 7 multipliers successfully conform to the expected output voltage level.

6.1.2) Ripple Voltage

Ref.: Appendix I, Sheet 1, Cond. B1 & B2
Test Circuit Fig. 3, Fig. 5

Method: With 1000 Vp/p @ 20 & 35 KHz applied, record the output ripple voltage using a "Jennings Type" scope probe

Results: The 7 multipliers successfully conform to the $<3\%$ requirement of SCS-495, Para 3.2.1.4.

6.1.3) Charge Current

Ref.: Appendix I, Sheet 1, Cond. C1 & C2
Test Circuit Fig. 4, Fig. 5

Method: With 1000 Vp/p @ 20 & 35 KHz applied, record the charging current

Results: The 7 multipliers failed to conform to the $<150\ \mu A$ requirement of SCS-495, Para 3.2.1.3 when tested at 35 KHz.

6.1.4) Input Capacitance

Ref.: Appendix I, Sheet 1, Cond. D1 & D2
Test Circuit Fig. 4, Fig. 5

Method: With 1000 Vp/p @ 20 & 35 KHz applied, record the input capacitance reading on the variable capacitor

Results: The 7 multipliers successfully conform to the <8 pF requirement of SCS-495, Para 3.2.1.2.

6.1.5) Output Voltage (Full Load)

Ref.: Appendix I, Sheet 1, Cond. E1 & E2
Test Circuit Fig. 2, Fig. 5

Method: With 1000 Vp/p @ 20 & 35 KHz applied, record the output voltage

Results: The 7 multipliers successfully conform to the expected output voltage level.

6.1.6) Efficiency Calculation

Ref.: Appendix I, Sheet 1, Cond. F1 & F2
Test Circuit Fig. 1, Fig. 2, Fig. 5

Method: Using the formula provided in Para 6.3.1 of SCS-495 the calculated multiplier efficiencies, with the output at full load (worse case), exceed the 85% requirement of SCS-495, Para 3.2.1.1.

7.0) Report Summation:

In this report we evaluated seven (7) Second Engineering Multiplier Samples per MM & T contract DDAB07-75-C-0041. The results indicated by the various test paragraphs conclude that none of the multipliers examined conform to "all" the electrical requirements as specified in the applicable paragraphs of SCS-495.

7.1) All seven multipliers fail to meet the 150 uA charge current requirement at room temp. when the input voltage frequency is 35 KHz.

NOTE: Electrical tests were conducted at room temperature conditions only.

8.0) List of Illustrations:

8.1) The five test circuit illustrations are contained in previously submitted ETR 0020.

Test #

ERIE TECHNOLOGICAL PRODUCTS
OF CANADA, LTD.

QUALITY CONTROL DEP'T. – RECORDED DATA SHEET
FILE NO. ETR 0021

SHEET # OF

NOTES # 2ND. ENG. SAMPLES

P.O. DAAB07-76-C-0041

F.O. 7459801-

QTY. 7pcs.

TEST Electrical Evaluation (Room Temperature)

PART T.S.K. 312-000 (6 STAGE RECT. MULTIPLIER MODULE)

SPECIAL DETAILS Re.: Fort Monmouth Specification SCS-495

Start Date 22 MAR./78

Finish Date 23 MAR./78

Tested By D.A.

Approved By QC Insp ERIE 20

	"A1"	"A2"	"B1"	"B2"	"C1"	"C2"	"D1"	"D2"	"E1"	"E2"	"F1"	"F2"
Test Date												
Test Cond.	"A1"	"A2"	"B1"	"B2"	"C1"	"C2"	"D1"	"D2"	"E1"	"E2"	"F1"	"F2"
Input Volt.	1000Vp/p	1000Vp/p	1000Vp/p	1000Vp/p	1000Vp/p	1000Vp/p	1000Vp/p	1000Vp/p	1000Vp/p	1000Vp/p	1000Vp/p	1000Vp/p
Test Freq.	20KHz	35KHz	20KHz	35KHz	20KHz	35KHz	20KHz	35KHz	20KHz	35KHz	20KHz	35KHz
Load Current	<2nA	<2nA	<2nA	<2nA	<2nA	<2nA	<2nA	<2nA	500nA	500nA	500nA	500nA
Parameter	O/P Volt.	O/P Volt	Rip. Volt	Rip. Volt	Chg. Cur.	Chg. Cur.	In. Cap.	In. Cap.	O/P Volt.	O/P Volt.	Cal. Eff.	Cal. Eff.
Units	Vdc	Vdc	Vp/p	Vp/p	μA	μA	pF	pF	Vdc	Vdc	%	%
Requirement	321	321	3214 <3%p/p	3214 <3%p/p	3213	3213 <150μA	3212 <8pF	3212 <8pF	321	321	3211 85% min	3211 85% min
IDENTIFICATION NUMBER: 77	5880	5850	26.0	26.0	150	345	6.59	6.66	5830	5840	97.2	97.3
78	5900	5870	15.6	15.6	145	330	6.46	6.59	5860	5830	97.7	97.2
79	5870	5840	18.2	18.2	150	345	6.59	6.74	5830	5800	97.2	96.6
80	5880	5850	13.0	13.0	150	330	6.58	6.68	5830	5820	97.2	97.0
81	5850	5820	15.6	15.6	150	340	6.53	6.65	5810	5800	96.8	96.6
82	5880	5830	15.6	15.6	150	335	6.49	6.59	5840	5800	97.3	96.6
84	5850	5820	10.4	10.4	130	310	6.83	6.92	5810	5810	96.8	96.8